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PRE-PROCESSING TECHNIQUES FOR FACIAL EMOTION RECOGNITION SYSTEM

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ABSTRACT

Humans share a universal and fundamental set of emotions which are exhibited through consistent facial expressions. Recognition of human emotions from the imaging templates is useful in a wide variety of human-computer interaction and intelligent systems applications. However, the automatic recognition of facial expressions using image template matching techniques suffer from the natural variability with facial features and recording conditions. In spite of the progress achieved in facial emotion recognition in recent years, the effective and computationally simple feature extraction and classification technique for emotion recognition is still an open problem. Image pre-processing and normalization is significant part of face recognition systems. Changes in lighting conditions produces dramatically decrease of recognition performance. In this paper, the image pre-processing techniques like K-Nearest Neighbor, Cultural Algorithm and Genetic Algorithm are used to remove the noise in the facial image for enhancing the emotion recognition. The performance of the pre-processing techniques are evaluated with various performance metrics.

Key words: Human Emotion, Image Processing, Image Noise removal, image enhancement, K-Nearest Neighbor.

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1. INTRODUCTION

Emotion recognition is being actively explored in Computer Vision research. With the recent rise and popularization of Machine Learning [1] and Deep Learning [2] techniques, the potential to build intelligent systems that accurately recognize emotions became a closer reality. However, this problem is shown to be more and more complex with the progress of fields that

are directly linked with emotion recognition, such as psychology and neurology. Micro-expressions, electroencephalography (EEG) signals, gestures, tone of voice, facial expressions, and surrounding context are some terms that have a powerful impact when identifying emotions in a human [3]. When all of these variables are pieced together with the limitations and problems of the current Computer Vision algorithms, emotion recognition can get highly complex. Face detection techniques are able to create bounding boxes that delimit detected faces, which are the desired regions of interest (ROIs) for a conventional FER system. This task is still challenging, and it is not guaranteed that all faces are going to be detected in a given input image. This is especially true when acquiring images from an uncontrolled environment, where there may be movement, harsh lighting conditions, different poses, great distances, among other factors [4].

Human emotion detection is implemented in many areas requiring additional security or information about the person. It can be seen as a second step to face detection where we may be required to set up a second layer of security, where along with the face, the emotion is also detected. Human emotions can be classified as: fear, contempt, disgust, anger, surprise, sad, happy, and neutral. These emotions are very subtle. Facial muscle contortions are very minimal and detecting these differences can be very challenging as even a small difference results in different expressions [4]. Also, expressions of different or even the same people might vary for the same emotion, as emotions are hugely context dependent [7].

Through this paper, an optimized image pre-processing technique is proposed to enhance the quality of the face image for improving the classification of the human emotion using KNN and Cultural algorithm. KNN is one of the most classification algorithm whereas CA used to take optimized K value for the KNN.

1.1. Background Study on Image Enhancement and Noise Removal

Recent times, image enhancement happens to be a factor of several image that is important and applications of computer vision. Image enhancement requires getting a graphic and enhancing it visually, commonly if you take advantageous asset of a reaction to stimuli that are visual. Sequences of enhancement methods are extensively utilized to enable the introduction of a remedy for computer image issues. A most of these techniques focused on low illumination or magnification that is high problems connected with noise persist. In an Image Enhancement technique [9], it is observed that why, noise removal is still an image that is important task. Image noise presents excessive or information that is undesired can happen through the image capture, acquisition, processing and transmission, and can even be dependent or in addition to the image content. The noise can be modeled with either a Gaussian, Uniform or Salt-and-Pepper distribution [10] in typical images. A filter is one thing that attenuates or enhances frequencies that are particular to visualize when you look at the frequency domain. Image filters are primarily applied to alter the characteristics of images such as colors, size, shading, and others. There is variety of use in image processing operations implemented with this filtering includes smoothing, sharpening, and edge enhancement.

2. RELATED WORKS

Bhattacherjee, Payal, and M. M. Ramya [11] utilized Fuzzy Logic for contrast development since it relates to uncertainties in image acquisition. New contrast development of facial images predicated on new enhanced fuzzy set theory is suggested. This paper geared towards adaptive enhancement that is fuzzy of facial images for pain evaluation. Every emotion is connected with certain mix of action units.

Amrapur, Basavaraj [12] utilized snake or contour that is active when it comes to segment of facial facts. The important facial characteristics gathered from images are used to verify (or) identify the human face.

Rathika, N., P. Suresh, and N. Sathya [13] explained a novel approach LS enhancement method utilizing Column-Wise Sliding Neighbourhood Operations (CWSNO) and General Sliding Neighborhood Operation (GSNO), and pulls the Principal Components Analysis (PCA) features with three straight ways such as median, mean and mode that are then categorized with Minimum Distance (MD) classifier using LOOCV (Leave One Out Cross Validation) of Re-Sampling Method (R-SM) to identify the faces.

Zhilali et. Al [14] have proposed a technique to extract facial features based on the Local Binary Pattern (LBP) with lighting affect. In the LBP method, it alters the face traits by acquiring the binary type through the thresholding result around pixels or commonly called neighbors pixels.

Oloyede et al [15] introduced a new evaluation method for enhancing the performance of the Meta Heuristic-based Image Enhancement technique. Basically, the authors employed this new evaluation function together with meta heuristic-based optimization methods so that you can select instantly the greatest enhanced face image predicated on a linear combination of various key measure that is quantitative.

Oulefki et al [16] aimed the effectiveness of the Contrast Limited Adaptive Histogram Equalization (CLAHE) protocol for face preprocessing. Fuzzy Inference System is applied to improve the annoyance of non-uniform illumination of face images in a targeted and precise manner. As a result the illumination problem is occurred due to low-light. Initially, the input face image is divided in to two sub-regions that are equal. Eventually, the amount of brightness in every sub-region plus in the face that is whole utilized for dynamic decision of whether or not to normalize.

Yang et al [17] suggested a GPU based Region Covariance Filter (RCF)-Retinex, that could boost region covariance filter with CUDA. It expansion is really feasible to utilize CUDA to parallel the covariance that is region because of its successive convolution operations, therefore it may receive the illumination image quickly.

Ilyas et al [18] recommended a Face Recognition (FR) system divided in to three steps: the face viola-Jones algorithm, facial image enhancement utilizing Adaptive Histogram Equalization algorithm (AHE), and show learning for classification.

Ravinaik, D., et al [19] introduced a concept that is novel modify the current power law transform to boost excellence of face region for better identification. The Double Density Dual Tree Discrete Wavelet Transforms (DDDTDWT) is employed to extract features. The Euclidian distance (ED) is employed to suit the acquired popular features of database and test face images to calculate performance variables.

Bendjillali, Ridha Ilyas, et al [20] presented a Face Recognition (FR) system divided in to three steps: the face that is viola-Jones algorithm, facial image enhancement using Modified Contrast Limited Adaptive Histogram Equalization algorithm (M-CLAHE), and show learning for classification.

3. PRE-PROCESSING TECHNIQUE FOR FACE RECONGITION

3.1. K Nearest Neighbor Technique

The K-Nearest Neighbor algorithm (K-NN) is a non-parametric method used for classification and regression in pattern recognition. Both in cases, the input is made from the K training are closest examples in the feature space. K-NN is a kind of instance-based learning. A test example classification is shown when look at the figure 1. Look at the test sample is a big dot within the

circles that will be classified both into the high grade of triangles or even the next class of squares. If K=5 (dashed line circle) it really is designated into the second class you can find 3 squares and 2 triangles inside that circle. If K=3 (solid line circle) it really is assigned into the second class because here 1 triangle and 2 squares within that circle. It could be useful in the event that weight contributions regarding the neighbours are believed considering that the nearer neighbours contribute significantly more than the distant ones. As an example, in a common weighting, individual neighbour is assigned to a weight of 1/d if d is the exact distance into the neighbour. The shortest distance among any two neighbours is often a straight line, the exact distance is recognized as Euclidean distance [19]. The limitation regarding the K-NN algorithm could it be's responsive to the local configuration of data. The entire process of transforming the input data to a collection of features is recognized as Feature extraction. In Feature space, extraction is taken put on raw data before you apply KNN algorithm.

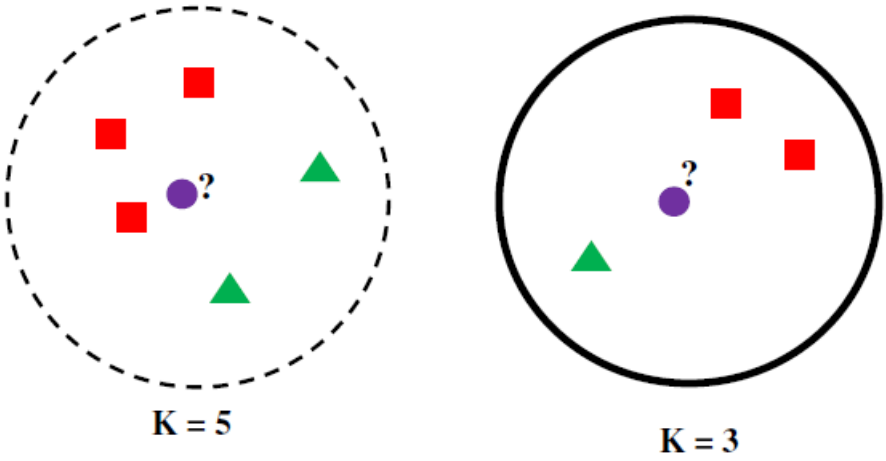

Figure 1 A K-Nearest Neighbor

3.2. Cultural Algorithm

The CA is a dual inheritance that defines evolution in human culture at both the macro-evolutionary level, which requires place inside the belief space, as well as the micro-evolutionary level, which happens in the population space. CA is made from a population that is social a belief space. Connection with individuals selected through the population space because of the acceptance function is employed to build problem solving knowledge resides when look at the belief space. The belief space manipulates and stores the ability acquired through the connection with individuals when look at the population space. The evolution can be controlled by this knowledge regarding the population component in the form of the influence function. Because of this, CA can offer a mechanism that is explicit global knowledge and a helpful framework within which to model self-adaptation in an EC system. The populace level element of the cultural algorithm be Evolutionary Programming (EP). The worldwide knowledge which has been learned because of the population should be expressed with regards to both normative and situational knowledge. In this algorithm, first the belief space in addition to population space are initialized. Then, the algorithm shall repeat processing for every single generation until a termination condition is achieved. People are evaluated making use of the performance function. The 2 amounts of Cultural Algorithm communicate by using the acceptance function together with influence function. The acceptance function determines which folks from the current population is selected to impact the belief space. The selected individuals' experiences that are generalized and applied to modify the existing beliefs when look at the belief space through the update function. This new belief is able to be employed to

guide and influence the evolutionary process when it comes to next generation. Cultural algorithms as explained above comprise of three components. First, there was a population component which contains the social population be evolved in addition to mechanisms for the reproduction, evaluation, and modification. Second there was a belief space that presents the bias which has been acquired because of the population during its problem-solving process. The third component is the communications protocol which is used to look for the interaction amongst the population and their beliefs. Cultural algorithm is in-depth analysis regarding the superiority regarding the evolution that is original on the cornerstone of drawing from the social (cultural) evolution theory when look at the social sciences [21].

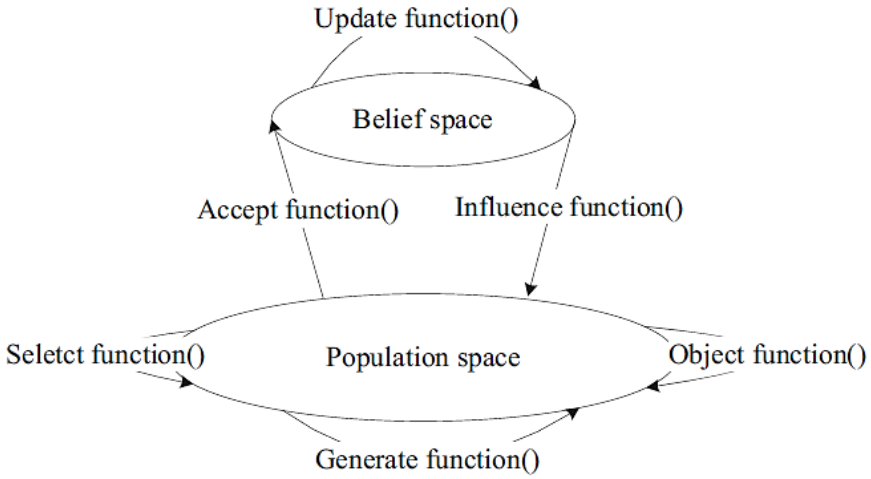

Figure 2 Cultural Algorithm Framework

3.3. Genetic Algorithm

d Genetic Algorithm is characterized by a search technique as described in the Darwin's evolutionist theory which adapts selection mechanism where individuals, that is the chromosomes, more adapted of a population are the ones that have more survival chances and can be used easily according to changes that occur in its environment. This makes the algorithm strong and fast in those situations where the search space is too big and the conventional methods become incident. In the genetic algorithm, the problem to be solved is represented by a list of parameters which drives an evaluation procedure, called chromosomes or genomes. Chromosomes can be defined as simple strings of data and instructions. In the first step of the algorithm, such chromosomes are generated randomly or heuristically to form an initial pool of possible solutions called first generation pool. The following steps are involved in the Genetic algorithm for Face Recognition pre-processing technique.

Step 1: Firstly, suppose we have a population of N size, with chromosomes generated randomly;

Step 2: Apply fitness to each chromosome or genomes of population;

Step 3: Make new chromosomes or genomes through crossings of selected chromosomes of this population. (4) Apply recombination and mutation in these chromosomes;

Step 4: Eliminate old population members, so that there is enough space to insert new chromosomes, keeping the population with the same N chromosomes;

4. RESULT AND DISCUSSION

The face emotion recognition dataset is taken from the Kaggle repository [22]. The dataset is composed of angry, disgust, fear, happy, neutral, sad and surprise emotions. For this paper, 100 images from each emotion category is considered to evaluate the performance of the pre-processing techniques with two classification techniques like ANN, KNN and SVM.

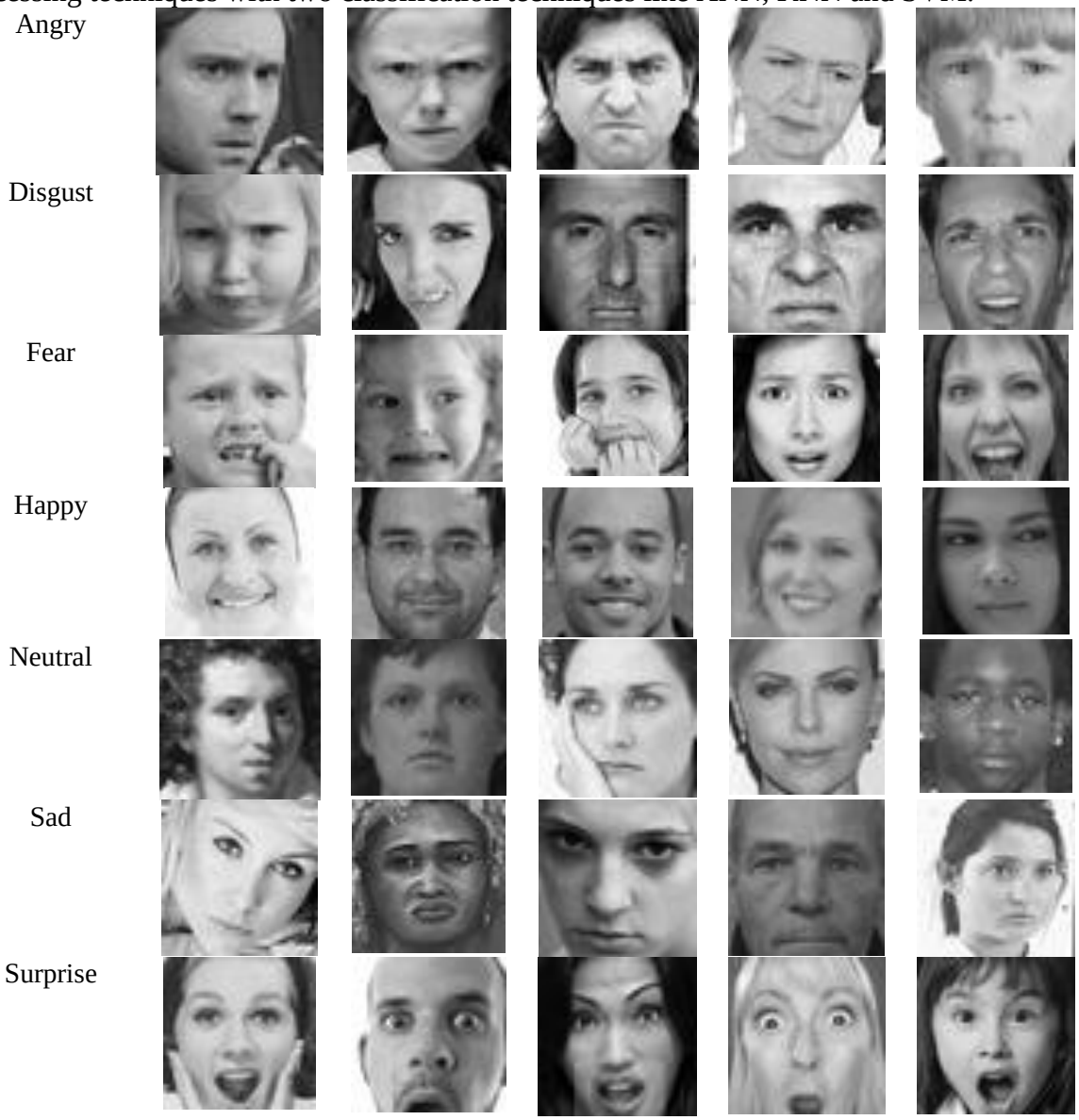

Figure 3 Sample human emotions images for analysis

4.1. Performance Metrics

Table 1 depicts the performance metrics are used in this research work.

Table 1 Performance Metrics used in this paper

Performance Metrics	Equation
Detection Rate	$\frac{TP + TN}{TP + TN + FP + FN}$
Sensitivity	$\frac{TP}{TP + FN}$

Specificity	$\frac{TN}{TN + FP}$
False Positive Rate	1- Specificity
Miss Rate	1- Sensitivity

Table 2 depicts the performance analysis of the pre-processing techniques with KNN and CA is compared using the classification techniques with ANN classifier for the classification of human emotion recognition with proposed technique. Table 3 presents the performance analysis of the pre-processing techniques with KNN and CA is compared using the classification techniques with KNN classifier. Table 4 presents the performance analysis of the pre-processing technique with KNN and CA is compared using the classification techniques with SVM classifier.

From the table 2, table 3, and table 4 it is clear that the Pre-Processing technique with ANN performed better in terms of increased Detection Rate, sensitivity, Specificity and reduced error rates like FPR, and Miss Rate than the other pre-processing techniques with ANN, KNN and SVM classifiers.

Table 2 Performance analysis of the image pre-processing techniques using ANN classification

Performance Metrics (in %)	**Techniques for Pre-Processing of Images**		
	Genetic Algorithm	**KNN**	**CA**
Detection Rate	51.78	56.52	53.69
Sensitivity	51.86	56.55	53.68
Specificity	51.52	56.49	53.70
False Positive Rate	47.8	43.51	46.3
Miss Rate	47.44	43.45	46.32

Table 3 Performance analysis of the image pre-processing techniques using KNN classification

Performance Metrics (in %)	**Techniques for Pre-Processing of Images**		
	Genetic Algorithm	**KNN**	**CA**
Detection Rate	50.64	53.55	51.88
Sensitivity	50.27	53.55	51.89
Specificity	50.61	53.52	51.88
False Positive Rate	49.24	46.48	48.12
Miss Rate	49.54	46.45	48.11

Table 4 Performance analysis of the image pre-processing technique using SVM classification

Performance Metrics (in %)	**Techniques for Pre-Processing of Images**		
	Genetic Algorithm	**KNN**	**CA**
Detection Rate	52.52	49.21	50.31
Sensitivity	52.41	49.211	50.23
Specificity	52.123	49.21	50.234
False Positive Rate	50.132	50.79	49.766
Miss Rate	51.59	50.79	49.77

5. CONCLUSION

Human face recognition and human emotion recognition is a challenging task because of the variability of facial expressions, personal appearances, variant poses, and illumination. An image pre-processing technique using Genetic Algorithm (GA), Cultural Algorithm (CA) and K-Nearest Neighbor (KNN) is proposed to enhance the quality of the image by removing the noise, illumination in the face emotion images. From the result obtained by the proposed pre-

processing techniques with ANN classification method produced enhanced detection rate, sensitivity, specificity for finding the human emotion and it also gave less error rates.

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